

359/385

**DYNOPTIC  
LABROSCOPES**

**REFERENCE MANUAL**



**BAUSCH & LOMB**  
OPTICAL COMPANY  
ROCHESTER 2, NEW YORK

359/385

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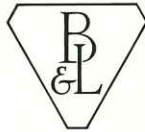
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# DYNOPTIC LABROSCOPES



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BAUSCH & LOMB OPTICAL CO.  
ROCHESTER 2, N. Y.

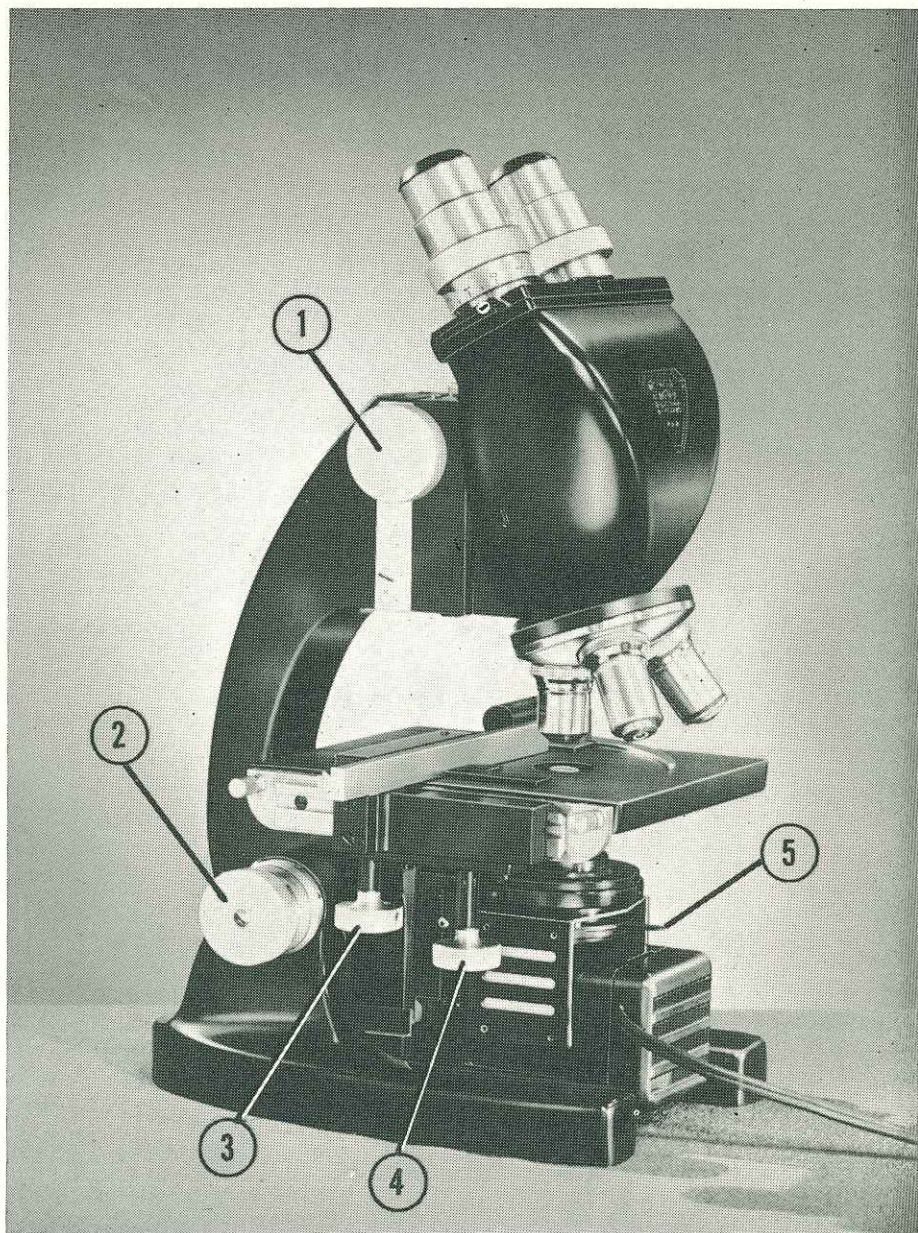
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*Fig. 1—Bausch & Lomb Labroscope, Model TBV-8L*



# B&L DYNOPTIC LABROSCOPES

## Introduction

The biological microscope has been, in the past, referred to as a Laboratory Microscope. Actually, practically all types of microscopes—biological, polarizing, stereoscopic wide field, metallurgical, etc.—are used in laboratories and the term “Laboratory Microscope” loses meaning. Therefore, Bausch & Lomb has replaced this ambiguous term with Labroscope, meaning that particular type of microscope which is ordinarily used for routine examination and analysis in the laboratory.

In the following pages we shall attempt to explain how to use your microscope most effectively. Due to

the many possible combinations of optical and mechanical equipment with which the Bausch & Lomb Labroscope may be equipped, it would be impossible to lay down any set operating procedure which would satisfy all users. It must be left to the reader to ignore references to equipment which he does not have and concern himself only with that which is pertinent to his particular equipment.

Figure 1 is an illustration of the Bausch & Lomb Labroscope Model TBV-8L equipped with the Opti-lume attachable substage illuminator.

Figure 2 is a cutaway drawing showing the mechanical construction of a typical Labroscope.

## UNPACKING AND SETTING UP

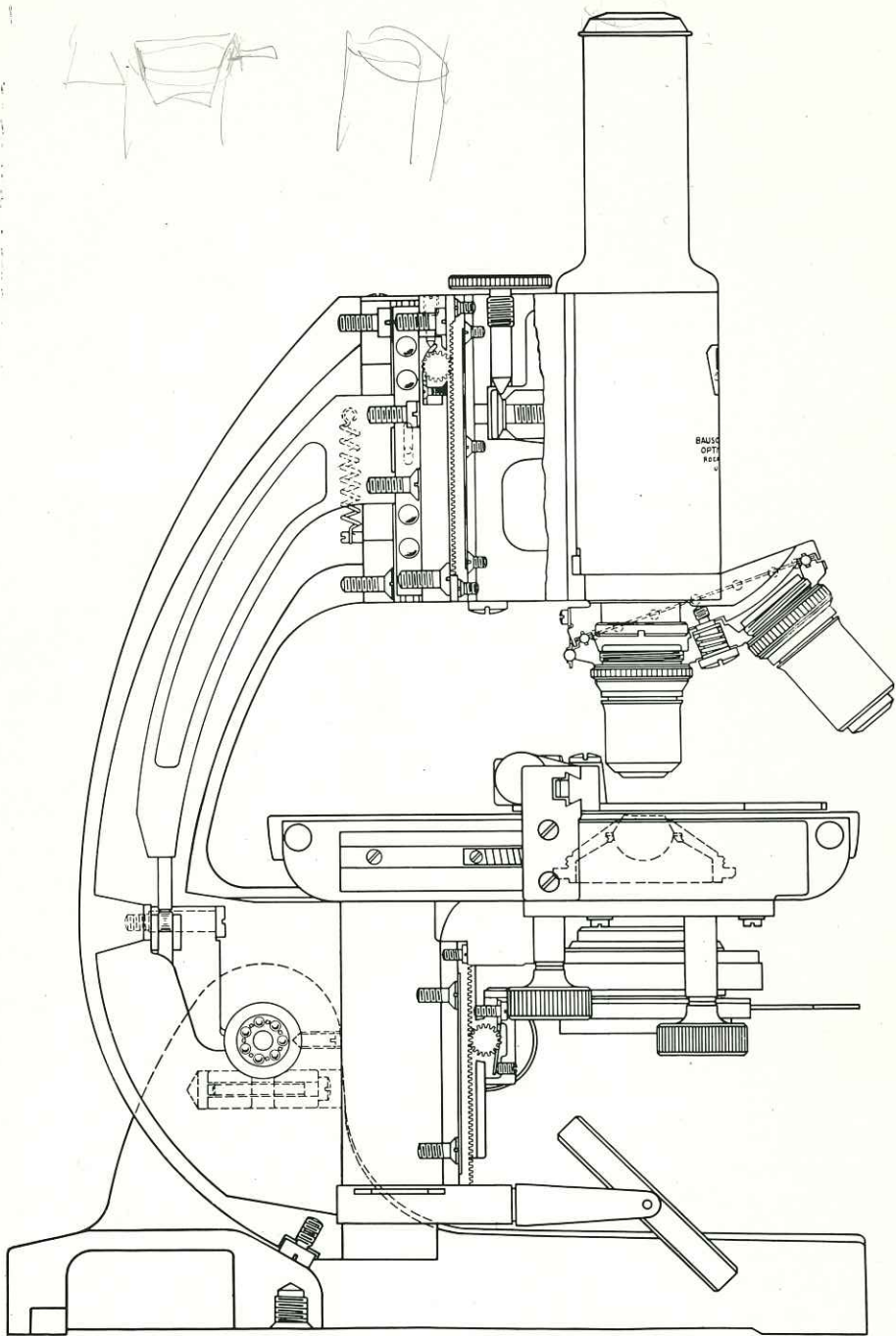
The instrument will come to you packed in a wood case. A screw extending through the bottom of the case holds the microscope securely in place, and must be removed before the microscope can be taken from the case. A screwdriver or coin can be used to remove the screw. After removing the packing material and screw, the microscope can be pulled out of the case by a straight outward pull. Eyepieces and objectives are stowed in a rack at the top of the case, the objectives in bakelite boxes with screw caps.

The table and the chair or stool should be of such heights that observations can be made with the greatest possible degree of physical comfort, avoiding straining the neck or com-

pressing the chest, for an unfavorable position induces unnecessary fatigue, with accompanying eyestrain if observation is prolonged.

### Tilting at Inclination Joint

As a further aid in comfort of observation, particularly when using a microscope with a monocular or vertical binocular body, it is possible to tilt the microscope at the inclination joint to an angle of from 30° to 45° from the vertical, if the character of the work to be done permits it. The inclined binocular body permits one to maintain a horizontal stage and, at the same time, view the image from a comfortable angle.



*Fig. 2—The Mechanical Construction of the Bausch & Lomb Labroscope*

### **Setting Draw Tube**

The instrument may or may not have a draw-tube. If it has, the draw-tube should be adjusted until the 160mm mark engraved on the tube is coincident with the upper end of the body tube.

To complete the setting up of the microscope proper it is only necessary to insert the eyepieces and attach the objectives.

### **Placing Eyepieces**

If there are two or more eyepieces of different power, always use the lowest power first. The exterior surfaces of the eye-lens and field-lens, being exposed, are apt to become dusty, and should always be carefully cleaned before using. Eyepieces are so loosely fitted that they will drop into the tube as far as the collar by their own weight. Care must be used in placing the eyepiece as the focus may be disturbed, or the objective forced against the object and thus destroy it.

When using a binocular body one should check to be sure that both of the eyepieces being used are of the same power and type. Eyepieces for use in binocular bodies are usually sold in matched pairs, and they should be used as such for optimum results.

### **Attaching Objectives**

The microscope will almost always be

provided with a revolving nosepiece into which two or more objectives may be mounted.

Taking the low power objective (10 $\times$ , 16mm) remove it from its box and see that its front and rear lenses are clean; elevate the tube of the stand by means of the coarse adjustment so that the nosepiece shall be at least two inches from the stage.

To attach an objective properly is not always simple, but must be done very carefully. There is danger of dropping the objective onto the object, thereby damaging either or both; also of starting the threads wrong by holding the objective sideways, and thus injuring the threads.

Grasp the upper knurled edge of the objective between thumb and forefinger of the left hand; bring the screw in contact with the screw of the nosepiece, and, keeping the objective in line with the tube and gently pressing upward, revolve the objective with the thumb and forefinger of the right hand by the lower milled edge until shoulder sets against shoulder.

The objectives may be placed on the revolving nosepiece in any desired order. It is usually most convenient to arrange them so that the magnification increases as the nosepiece is revolved in a clockwise direction.

## **GENERAL OPERATING PROCEDURE**

It will be found that, in the course of normal use of the microscope, one follows a set pattern of operations. These operations must, of necessity, follow one another and may be classified under four main headings:

1. Place the specimen on the stage
2. Illuminate the specimen
3. Find and focus on the specimen
4. Use the revolving nosepiece for ex-

amination under higher magnification.

### **Placing Specimen on Stage**

The preparation to be studied under the microscope is usually mounted on a glass slide which measures about 1" x 3" and is about 1.3mm thick. Some means must be provided on the stage to secure this slide in position once



some particular point of interest has been found and, at the same time, the slide must be movable as desired. The stage will be equipped with either spring clips or a mechanical stage.

If the microscope is equipped with spring clips, simply place the object slide under the clips, cover glass upward, and move it until the object is approximately over the center of the stage opening. If the spring clips do not appear to exert sufficient pressure on the object slide, check to see that the holding pins at the ends of the clips are fully inserted in the holes in the stage.

To place an object slide on the mechanical stage, press inward on the lever which is located at the rear left hand corner of the mechanical stage (Fig. 3—6). This will cause the Vacutrol finger (Fig. 3—7) to open, and the slide may be placed within the mechanical stage, its right and rear edges contacting the corresponding edges of the mechanical stage. The bottom of the slide should rest on the microscope stage and not on the mechanical stage. Release the finger control lever, allowing the finger to close, holding the slide within the mechanical stage. The finger pressure is controlled by a vacuum controlled spring—the pressure being sufficient to hold the slide firmly but not so great as to break the corner of the slide even if released from its full open position. Using the mechanical stage controls, move the slide until the object is approximately over the center of the stage opening. The forward mechanical stage button (Fig. 1—4) moves the stage in the north-south direction; the rear button (Fig. 1—3) moves it east-west.

### **Illumination of the Specimen**

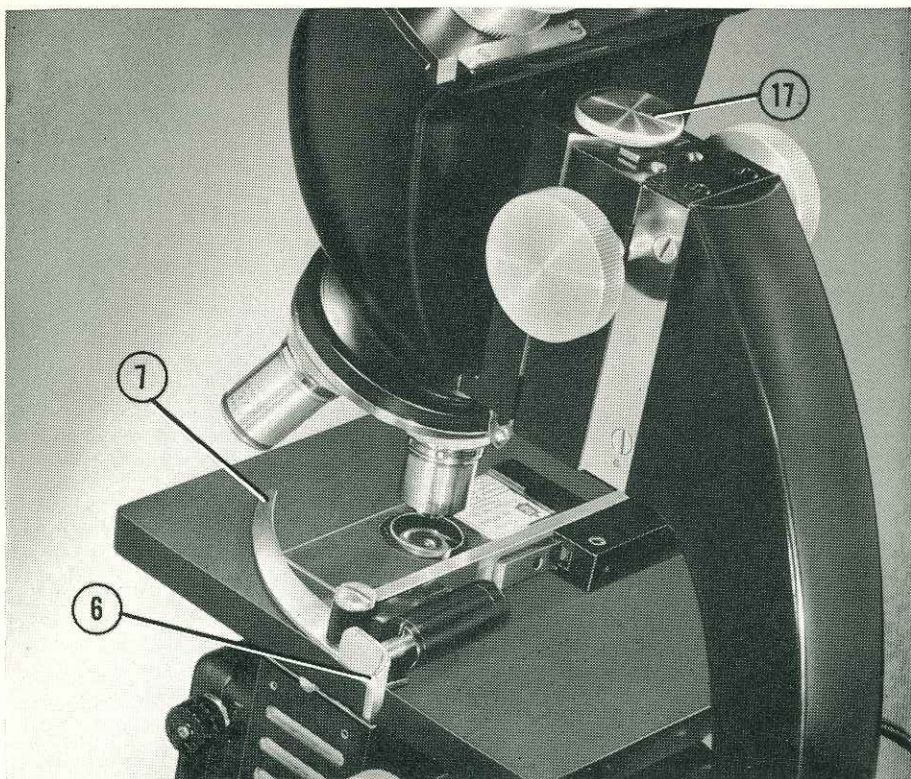
This subject will be dealt with in detail in a later section. Suffice it to say,

at the present time, that the larger illuminators such as the Spherical or the Micro-Lite should be placed about 6"-8" from the microscope and adjusted so that the light is striking the substage mirror centrally. If using the Opti-lume in conjunction with the mirror, place the illuminator about 3" away from the mirror. Adjust the mirror until the object appears illuminated when viewed from the side. (When using the Opti-lume as an attached substage illuminator the above adjustments are unnecessary.) Further adjustment of the illumination will have to be done after the microscope is focused on the object.

### **Finding and Focusing on the Specimen**

Unless one is thoroughly familiar with the object to be studied, it will be advantageous to start examining it under low magnification, proceeding to higher powers as specific points of interest are found during the low power survey. In any event, even if it is known that one wishes to examine a certain portion of the object with, say, the 4mm objective, it is extremely unlikely that the slide will be positioned on the stage, from the outset, so that the desired spot would fall within the field of view of the 4mm objective when first focused. Therefore, it would be wise in every instance to use first the 10× objective and 5× eyepiece. This combination permits the viewing of a field 2.0mm in diameter as measured in the object plane. The field may be examined and, when the particular point of interest is found, it should be moved to the center of the field of view. In this connection, it should be noted that a movement of the object to the right causes an apparent movement of the image to the left. This is due to the fact that the objective forms an inverted image of the object. After





*Fig. 3—Vacu-trol Slide Finger, Mechanical Stage*

a little practice one mechanically moves the object in the direction opposite to that which the eye seems to indicate. Once the object has been brought to the center of the field of view, the higher power objectives may be brought into position by means of the revolving nosepiece.

To focus a microscope is to adjust the relation between the optical system and the object so that a clear image is obtained. With higher power objectives the distance between the cover glass and the front lens of the objective is so short that unless the operation of focusing is conducted with care and skill there is danger of damaging the specimen, the objective, or both. In lower power objectives the danger is

less because of the greater working distance (distance from slide to objective). It is wise, therefore, for the beginner in microscopy to practice the operation of finding an object and focusing with low powers first, and then proceeding to the higher powers as his touch becomes more sure and his conception of how an image comes into and goes out of focus develops.

#### **Lower Power Objective**

Attach the objective to the nosepiece. Lower the head to the level of the stage, to be able to see the front of the objective; lower the tube by the coarse adjustment until the front of the objective is within one-quarter inch of the object; look through the eyepiece and



slowly elevate by the coarse adjustment until the image is distinct. Then use the fine adjustment to effect the final focus.

The upward movement should be slow so that, if the object be faint, it is not missed and the adjustment not run beyond its focal distance; or it is possible that, in the case of a very minute object, it may be out of the center, and thus out of the field of vision, in which case the surface of the cover glass, or the minute particles of dust upon it, should be distinguishable.

The object will first appear with faint outlines and indistinct; then gradually more distinct, and finally sharply defined, and if adjustment goes beyond this point, it will gradually become more dim. In this case return to the point of greatest distinctness.

Objectives which make up the regular outfits are so adjusted as to be par-focal, i.e., are so fitted to the nosepiece that as either one is swung into position, it is so nearly focused as to require only the use of the fine adjustment. Therefore, once having focused with the 10 $\times$  objective, it will not be necessary to repeat the whole focusing procedure upon changing to the next higher powered objective. (This assumes, of course, that a revolving nosepiece is being used.) Merely swing the next objective into position; a slight adjustment of the fine adjustment button is all that will be needed to restore perfect focus.

If your microscope is equipped with a single nosepiece, it will be necessary to focus each objective as it is used. The focusing procedure when using the higher powered objectives is much the same as that given above but it should be carried out with great care due to the proximity of the front lens of the objective to the cover glass. The procedure is outlined below.

### High Power Objective

Attach objective to nosepiece. Lower the head to the level of the stage and look between the objective and the cover glass. Slowly lower the objective with the coarse adjustment until the front of the objective is nearly in contact with the cover glass. Look into the eyepiece, slowly elevate the tube by the coarse adjustment until the image appears. Use the fine adjustment for final focusing.

It is also advisable, while watching for the image to appear, to move the object slowly in different directions, as the flitting of shadows across the field will give indication that the objective is nearing the focal point.

Always focus upward. In case there is no revolving nosepiece and the low power is exchanged for a higher power objective, or when the low power has been used as a searcher, i.e., to find a certain object in a collection, or a certain locality in a specimen, the tube should first be elevated, as working distance in the high power is too short to admit of screwing it into the nosepiece; then detach the low power, attach the high power and proceed to focus in the order given.

### Oil Immersion Objectives

Immersion contact between the objective and cover glass is made with an oil which is specially prepared so as to have the same refractive index as the front lens. Great care should be used to keep it free from dust.

Apply a small quantity of oil to the front lens of the objective or to the cover glass, using for this purpose the rod in the oil bottle. Lower the objective very carefully with the coarse adjustment until contact is made. This can best be determined by watching the space between objective and slide with the eye well down to the level of the stage. At the instant contact is



made a flash of light will illuminate the oil. When this flash is seen, the objective will be near enough to focus by means of the fine adjustment.

The presence of dust or air bubbles in the immersion oil may destroy the definition of the best objective, therefore it is very essential to keep the oil bottle stoppered at all times. If bubbles are trapped between objective and slide, it may be necessary to apply fresh oil and re-focus in order to get rid of them.

Special care must be observed if a low power objective is used after an oil immersion. The oil must invariably be removed from the top of the cover glass by wiping with lens paper. The front of the objective should always be cleaned in the same manner immediately after it has been used.

### **Autofocus**

The Bausch & Lomb Labroscope is equipped with an Autofocus mechanism which is of particular value when changing from the use of a dry objective to an oil immersion objective. The painstaking focusing of the oil immersion objective is obviated by virtue of this feature, as the oil objective can be brought into focus with a minimum of effort. Its proper use is as follows:

With a dry objective in place on the nosepiece, raise the microscope body tube, by means of the *fine adjustment*, to its uppermost position. Lower the body tube to its lowest extent, using the coarse adjustment. Bring the specimen into focus by focusing downward with the fine adjustment. Do not disturb the coarse adjustment when focusing the dry objective. To use the oil immersion objective, raise the body tube by means of the coarse adjustment, (do not disturb the fine adjustment), bring the oil objective into position and apply

oil to the tip of the objective or to the specimen slide. Lower the body tube to its lowest extent, using the coarse adjustment only. The specimen will now be in approximate focus, requiring only a slight adjustment of the fine adjustment mechanism to bring it into perfect focus.

### **Fine Adjustment**

The low position fine adjustment button is shown (Fig. 1—2). The purpose of the fine adjustment is to provide a much greater degree of sensitivity in focusing than can be obtained with the rack and pinion coarse adjustment. Each division of the fine adjustment button represents one micron (0.001mm) vertical motion of the microscope body tube; each revolution of the button, therefore, raises or lowers the body tube 0.1mm. The motion of the fine adjustment is limited to 20 turns or 2.0mm travel. In order to protect the object slide and objective, the mechanism is so arranged that if the objective should be lowered so much as to touch the object slide, the downward motion of the body tube would cease, even though the fine adjustment button continues to rotate.

The low position of the fine adjustment button makes it possible to rest the arm on the table top while manipulating it. Moreover, only a slight movement of the hand is required to shift from use of the fine adjustment to manipulation of the mechanical stage controls.

### **Use of the Roto-sphere Revolving Nosepiece**

This is provided in order to enable rapid, convenient exchange of one objective for another. To effect this exchange, grasp two of the objectives between the thumb and forefinger of the right hand and rotate until the

desired objective is brought into line with the axis of the body tube. It is very important that exact alignment

be obtained. The correct setting is indicated by a slight click which indicates the stop for each objective.

## ILLUMINATION

Much of the literature concerning microscopy has been devoted to the subject of the methods and techniques of proper illumination. This is justly so, as improper illumination may easily lead to an erroneous interpretation of the microscopical image. However, there is no touch of magic involved in this matter, as one might be led to believe if he followed all of the arguments between the adherents of "critical" illumination and those who favor "Koehler" illumination. (Briefly stated, the term "critical illumination" implies that the light source is imaged, by the substage condenser, in the plane of the object; "Koehler illumination" is that form in which the light source is imaged in the front focal plane of the substage condenser and the lamp condenser is imaged in the plane of the object.)

It has been found that, as a practical matter, proper illumination is

achieved if two conditions are satisfied:

- a). The back lens of the objective should be filled with light when the iris diaphragm is opened to a sufficient extent.

- b). The field of view should be evenly illuminated.

### Substage Condenser

Satisfactory work with objectives of numerical aperture greater than 0.25 cannot be done without the use of a substage condenser. This condenser collects the light sent forth by the light source and converges it into a cone of sufficient angle to fill the back lens of the objective with light (up to the stated numerical aperture of the condenser.) The condenser should be fitted with an iris diaphragm in order that the angular aperture of the illuminating cone can be controlled.

Your Labroscope will, in all probability, be equipped with either an Abbe condenser or a variable focus condenser.

### Variable Focus Condenser

The patented Bausch & Lomb Variable Focus Condenser is by far the most convenient type to use for routine microscopy. Proper illumination with respect to both field and aperture is achieved simply by the proper positioning of the lower element of the condenser. It is not necessary to remove condenser lenses when using low power objectives as is necessary when using condensers of conventional construction. The Variable Focus Condenser is substantially a two-lens Abbe condenser in which the upper element is

*Fig. 4—Rack and Pinion Variable Focus Condenser*





mounted in a fixed position in the microscope stage and the lower element is independently focusable.

The Bausch & Lomb Labroscope is available with one of two forms of the variable focus condenser. In the first form, illustrated in Figure 4, the lower condenser element is focusable by means of a rack and pinion mechanism. The iris diaphragm is attached to the lower condenser element. With this type of equipment, it is possible to remove the condenser elements (see page 22) to permit the use of other condensers, such as the Dark Field Illuminators.

The second form of the Variable Focus condenser, known as the Verti-slide condenser (Figure 5) has the elements mounted within a tubular casing. The lower element is raised and lowered by means of the black ring which is slid vertically. In this instance, the iris diaphragm is fixed with relation to the upper condenser element. Labrosopes equipped with the Verti-slide condenser are not adaptable for the use of other forms of condensers such as the Dark Field Illuminators.

Any convenient light source that provides an extended area of uniform illumination can be used. After a light source has been chosen and placed approximately four to six inches in front of the microscope mirror, the latter can be adjusted and work with the microscope proceed in the following manner:

Move the focusable lens to its uppermost position and with the 10 $\times$  objective and a 5 $\times$  eyepiece in position adjust the plane substage mirror until the illuminated area on the specimen appears centered. If the 10 $\times$  objective is to be used in the work to follow, the lower condenser lens should be moved down toward the mirror until the field of view is fully illuminated.

It should be noticed that moving this lens down increases the illuminated field and decreases the numerical aperture, while moving it up decreases the illuminated field and increases the numerical aperture. Thus, when high power objectives are used, the movable lens should be in its top position and when low power objectives are employed, this element should be in its low position.

If it appears impossible to fill the field of a low power objective, it indicates that the light source is too far away for its area. However, it is not possible completely to fill the field of the 48mm objective and 5 $\times$  eyepiece.

### Abbe Condenser

Abbe condensers are usually neither chromatically nor spherically corrected, but for all ordinary work serve their purpose very well. Their function is to send light through the object under an angle sufficiently large to fill the aperture of the objective with light. They are furnished in three numerical apertures: 0.70 N.A. and 1.25 N.A.,

*Fig. 5—Verti-slide Variable Focus Condenser*



containing two lenses, and 1.40 N.A., containing three lenses.

The condenser mount fits into the substage from below and is provided with an iris diaphragm, which controls the amount of light entering the condenser and the angle of the emitted cone. It is also provided with a carrier for holding a blue glass disc.

The blue glass disc is used with artificial light to make the color of the light nearer that of daylight.

### **Choice of Mirror**

The choice of which mirror to use—plane or concave—depends, for the most part, on the type of illumination and the objective being employed. The condenser is designed so that parallel rays of light from the illuminating unit are brought to a focus in the plane of the specimen. The concave mirror will cause these rays to converge more rapidly and the apex of the cone of light will fall within the condenser. Therefore, when using parallel light as one does for strictly "critical" illumination or for dark field illumination the plane mirror should be used with the condenser.

When a diffusing surface, such as a ground glass, is placed between the illuminator bulb and the microscope mirror, as is the case with the Micro-Lite and the Opti-lume, parallel light is not being used. The use of the concave mirror permits the illumination of a larger field for low power work in addition to giving a more intense illumination. It may not be possible, however, to completely fill the aperture of the oil immersion objective when using the concave mirror.

Therefore, for general use of the microscope, the use of the plane mirror is recommended, reserving the concave mirror for use with the lower power objectives.

### **Focusing the Abbe Condenser**

This is a matter that assumes a high degree of importance when working with high aperture objectives. Rack and pinion adjustment of the condenser for focus is provided in all but the simplest equipments. The procedure is very simple. Focus the microscope on the object and then slowly focus the condenser up and down until the light source can be seen through the microscope. This can generally be detected by recognizing some detail of the light source. One of the reasons for carrying out this adjustment is to see that the back lens of the objective is filled with light and, in fact, it is generally satisfactory to judge the condenser adjustment by removing the eyepiece, putting the eye at the top of the tube and focusing the condenser until the back lens of the objective is filled with light, having first, of course, opened the substage diaphragm to its full aperture. This method of adjustment will permit a little leeway in setting. The best opinion favors setting the condenser at the highest rather than the lowest end of the range within which it meets the above condition. Of course, if a condenser of less numerical aperture than is possessed by the objective is used, it will be found impossible to fill the back lens of the objective with light.

### **Use of Substage Iris Diaphragm**

The substage iris diaphragm is provided to limit the angle of the cone of illumination to that value which is best suited, as determined by experiment, for the object under examination. In the examination of most microscopic preparations, the problem is to differentiate structure difficult to see, because its color or opacity differs so little from its surroundings, rather than to observe detail at the limit of resolution of the objective. The skillful



use of the substage diaphragm will be found extremely helpful in examining such specimens by increasing contrast and improving definition. Often, different diaphragm openings are required for different types of detail within the same preparation. Experience and attentive study are required to learn the most effective use of the diaphragm. The last use to which it should be put is to use it to control intensity of illumination. If the light is too bright, it may be reduced by means of neutral filters introduced between the light source and condenser.

Under no circumstances should the diaphragm be opened wider than is sufficient to fill the objective with light (tested by looking at the back lens after removing eyepiece), and generally it is advisable to start with only about two thirds of the back lens filled. From this point, open and close the diaphragm until the best vision is obtained of the detail in which you are interested.

#### **Using Abbe Condenser with Low Power Objectives**

The focal length of the condenser is small, and consequently it forms so small an image of the artificial light source that it usually fails to cover the field of objectives of powers  $10\times$  or less. For this reason condensers are constructed so that it is easy to unscrew the top lens, leaving then a condenser of much longer focal length. When the top element is removed from the 1.25 N.A. condenser, it has a numerical aperture of 0.30. When the top element is removed from the 1.40 N.A. condenser, the resulting aperture is 0.70 and with the two upper elements removed, 0.40.

If, in using low powers with the condenser, you are troubled by too small a field of illumination, remove the top lens of the condenser and readjust the

focusing of the condenser. Generally it will be found impossible to rack the condenser down far enough actually to image the light source on the slide, but this is not important in low power work. It will be sufficient to focus the condenser so as to fill the objective with light.

#### **Condenser With Oil Objectives**

It has often been stated that there is absolutely nothing gained in using an oil immersion objective unless the condenser is also oil immersed. This is not so. Experience has indicated that the most satisfactory image is the result of a compromise between resolution and contrast, and that this is obtained when the objective is used at approximately  $\frac{2}{3}$  of its maximum aperture. This condition is almost automatically established when an oil immersion objective is used with a dry condenser. It is, therefore, common practice to use oil immersion objectives without immersing the condenser. (The objective, of course, must be immersed).

It is true, however, that the objective will be unable to deliver its maximum resolving power unless its back aperture is filled with light, and this condition cannot be satisfied for an oil immersion objective unless the condenser is also oil—contacted to the slide. To accomplish this, place a drop of oil on the top lens of the condenser, place the slide on the stage and then bring up the condenser with the focusing adjustment until contact of oil and slide is established.

With all objectives having a numerical aperture less than 1.00, the condenser may, at all times, be used dry, i.e., without oil.

#### **Centration of the Condenser**

Centration of the condenser to the microscope axis is adjusted at the factory for all microscopes except those equipped with the Simple, Centering

Substage. This factory adjusted centration cannot be disturbed except by violent accident or by tampering. In such a case, the microscope should be returned to the factory for repair. In the centering substage, provision is made for centering the condenser principally to facilitate adjustment of illumination for critical microscopy and photomicrography. A convenient procedure to follow in making this adjustment is as follows:

Using a 10× objective which is

focused on the stage, close the substage iris diaphragm to a very small opening. Remove the eyepiece and look down the tube at the back lens of the objective. An image of the diaphragm aperture will be seen lying approximately in the plane of that lens and should be concentric with its rim. If it is not centered in the back lens of the objective, it can be brought to this condition by laterally adjusting the condenser by means of the two centering screws provided.

## ILLUMINATORS

Just as the construction and equipment of the various types of microscopes range from the simple to the most complex, so does the construction of the various types of microscope illuminators. In its simplest form, a low wattage bulb behind a piece of ground glass will serve as an adequate illuminator for most visual microscopical work. The more complex illuminators are equipped with highly corrected condensing systems, an iris diaphragm, and a light source of fairly high intensity.

An inexpensive illuminator such as the Bausch & Lomb Opti-lume, attachable, integral illuminator (Fig. 6—8) or the Micro-Lite (Fig. 7) will provide adequate illumination for the Labroscope. Moreover, these illuminators do not require the critical adjustment necessary for the more advanced illuminators.

### Micro-Lite

The Bausch & Lomb Micro-Lite (Cat. No. 31-33-01) utilizes a 60 watt bulb, of the household type, and may be plugged into any 115-120 volt circuit. The Micro-Lite has a condensing lens which has one surface ground to provide evenly diffused illumination. Simply place the illuminator about 6"-8"

from the microscope mirror and tilt the mirror until the light appears to be striking it centrally. Adjust the mirror and substage condenser until the microscope field and objective aperture are fully and evenly illuminated.

To replace the bulb, loosen the small screw located on the under side of the lamp housing, and remove the front portion of the housing. Unscrew the burned out bulb, replacing it with a new one, and re-assemble the lamp housing.

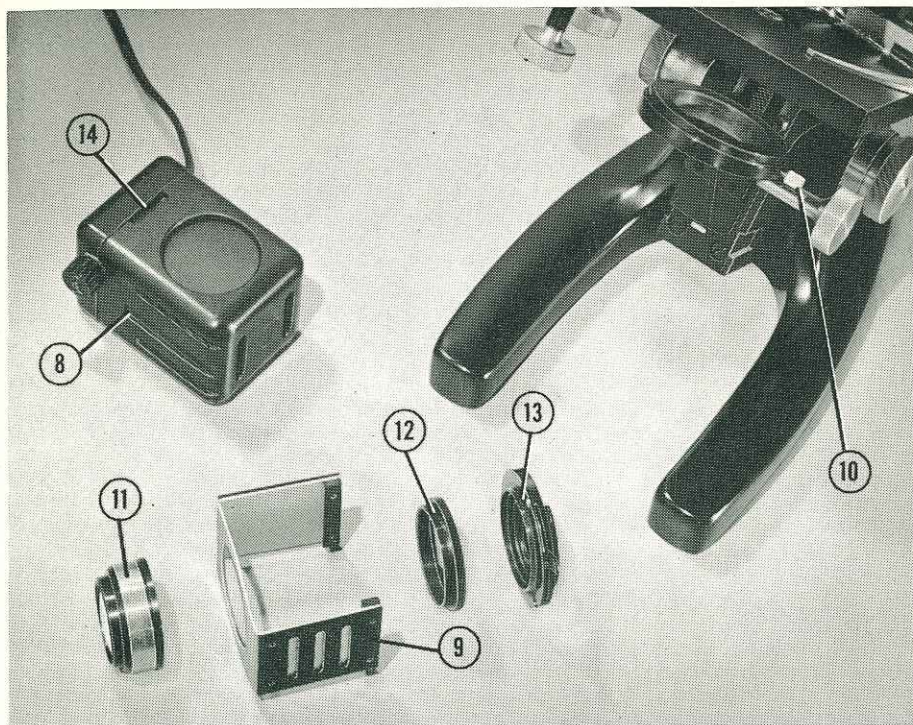
### Opti-lume

The Bausch & Lomb Opti-lume substage illuminator (Catalog No. 31-33-02) is a convenient, compact unit designed to provide sufficient light for all visual observations of transparent specimens in bright-field illumination. It may be used in three ways: (1) with the microscope mirror, (2) without the microscope mirror, or (3) attached to the substage equipment of the microscope.

### Opti-lume With Mirror

In cases where it is desirable to leave the mirror on the microscope, place the Opti-lume on the table in front of the microscope at a distance of two to





*Fig. 6—Assembly of Opti-lume as Attached Substage Illuminator*

three inches from the microscope mirror. The switch knob and electrical cord should be next to the table. Connect the cord to any 115 volt line. Turn the switch knob clockwise to turn on the lamp.

Position the Opti-lume to place its window centered with the microscope mirror and squared with the microscope base. Tilt the mirror and adjust the substage condenser until the field of view is brightly and evenly illuminated.

#### **Opti-lume Without Mirror**

The Opti-lume may be placed on the table directly beneath the substage condenser of the microscope, provided that the mirror is removed. The "tuning fork" construction of the mirror support permits removal of the mirror

by simply pulling outward. With the mirror removed, lay the Opti-lume between the feet of the microscope base. The switch button should be to the left and toward the toe of the base. Move the Opti-lume to center it with the substage condenser and adjust the condenser until the field of view is brightly and evenly illuminated.

It should be realized that when the Opti-lume is used in either of the manners described above, the microscope should not be tilted at the inclination joint, else uneven illumination will result.

#### **Opti-lume Attached to Microscope**

By means of a special bracket assembly (Cat. No. 31-34-47) the Opti-lume may be attached to the substage assembly of the microscope, thereby becoming an



integral part of the microscope. This is by far the most convenient manner in which to use it as the microscope may be moved or tilted without danger of disturbing the conditions of illumination.

The No. 31-34-47 Bracket (Fig. 6—9) permits the attaching of the Optilume to any Bausch & Lomb Labroscope equipped with either a rack and pinion type substage or the tubular-type variable focus condenser. The mechanics of mounting the bracket are slightly different in the two cases.

#### **Attaching to Rack and Pinion Type Substage**

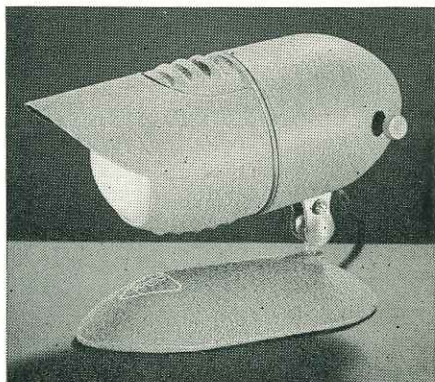
Fig. 6 shows a microscope equipped with a variable focus condenser with a rack and pinion movement for the lower condenser element. Remove the substage mirror assembly by pulling outward, and away from the substage support. Loosen the thumb screw (Fig. 6—10), remove the lower condenser element (the whole condenser, if not of the variable focus construction) and unscrew the iris diaphragm. Fig. 6 illustrates the order in which the components will have to be assembled. (11) is the lower condenser element; (9), the No. 31-34-47 bracket; (12), the adapter ring which is supplied with the bracket; and (13), the condenser iris diaphragm. Screw the iris diaphragm into the adapter ring and insert the ring and diaphragm assembly between the sides of the bracket, extending the thread of the adapter ring through the round opening in the bracket. Screw the condenser element onto the adapter ring thread, clamping the bracket between the substage condenser mount and the adapter ring. Locate the iris diaphragm so that its handle may be moved through its full excursion between the sides of the bracket. Slip the condenser element back into the ring mount of the substage, locating it in azimuth so that

the sides of the bracket are parallel to the sides of the stage and the iris diaphragm handle is at the front of the microscope when at the middle of its range of motion. Tighten the thumb-screw (10). With the window of the Optilume facing upward, insert the top half of the lamphouse between the sides of the bracket. Engage the two fiber strips on the inner sides of the bracket in the central slots along the sides of the lamphouse. Slide the Optilume into the bracket as far as it will go. With the lamp turned on, focus the substage condenser until the field of view is evenly illuminated and the back aperture of the objective is filled with light.

#### **Attaching to Tubular Type Substage Condenser**

Tilt the microscope at the inclination joint to a horizontal position. Remove the substage mirror and slide the lower condenser element to its upper position. With a small screw driver, loosen the three set screws in the condenser tube immediately above the filter holder in the bottom end of the tube. Turn the screws out equal distances, just far enough to permit removal of the filter holder. Insert the filter holder through the circular opening of the No. 31-34-47

*Fig. 7—Micro-Lite Illuminator*





bracket. (The adapter ring which accompanies the bracket is not used in this instance.) Slip the filter holder back into the end of the substage condenser tube and lock it in place by turning in the three set screws referred to above. Before locking the assembly securely, turn the filter holder so that the filter slot is positioned toward the front of the microscope and locate the sides of the bracket parallel to the sides of the stage. Insert the Opti-lume into the bracket as described in the preceding section.

### **Replacing Bulbs**

Should it be necessary to replace a burned out bulb, the lower portion of the lamphouse, containing the switch, lamp, and socket assembly will have to be removed. This is most easily accomplished by inserting a coin, such as a twenty-five cent piece, in the slot (Fig. 6—14) and twisting it, forcing the two parts of the lamphouse apart. The lower part may then be withdrawn, making the bulb immediately accessible.

Manufacturer designation for the replacement bulb is General Electric No. 15S11/102 (Refrigerator Lamp). These are available at all stores carrying lamps for general household use and household appliances. Replacement lamps may also be obtained from Bausch & Lomb; order by Catalog No. 31-31-15.

### **Replacing Filters**

Removal of the filter glass for cleaning or replacement is most easily done in the following manner. Place the lamp housing, window side up, on the table. Withdraw the bottom section as described above. Insert the first two fingers of one hand into the housing. Press downward on the sheet metal light shield and draw it outward at the same time. The light shield will slip out easily, carrying the filter with it. A

shallow, V-shaped spring between the box-like light shield and the rear wall of the lamphouse exerts sufficient pressure to hold the filter glass in place under the window of the lamphouse. When replacing the filter, first insert the spring through the bottom opening part way into the housing. The spring should lie with the apex of the V against the rear wall of the housing and parallel to the vent slots. Place the filter glass across the shoulders of the light shield opposite the circular opening in the shield. Holding the filter in place, press the light shield down on the V spring and slide the whole assembly into the housing. Filter, spring, and shield should all be pushed into the housing as far as they will go.

In the event that the ground condenser lens is involved, it is necessary to insert the lens first. In this case it will be more convenient to hold the lamphouse, window opening down. Place the lens in the opening, convex side outward. Lay the filter glass in over the flat side of the lens and slide the light shield part-way over the filter. Insert the V spring between the shield and rear wall of the housing, and slide the whole assembly into the housing.

The bottom of the lamphouse can be inserted in only one position. Align the lower switch knob with the V notch in the lower edge of the upper part of the housing and insert the bottom section into the housing.

In this section on "Illuminators" we have dealt with only two of the wide variety of illuminators which Bausch & Lomb offers for both visual microscopy and photomicrography. It would be beyond the scope of this pamphlet to deal in detail with the more elaborate illuminators. For further information concerning the Bausch & Lomb line of microscope illuminators, we invite you to write, requesting Catalog D-119.

## DARK FIELD ILLUMINATION

Illumination plays a very important part in all applications of the microscope. In the most common use of the microscope a strong beam of light is made to pass through the object. This is termed bright field microscopy, or microscopy in transmitted light. In order to be seen in bright field illumination, an object must absorb or refract the light passing through it so that contrast is set up between it and the surrounding medium. Objects displaying feeble contrast with respect to the background are very difficult to see in bright field illumination.

If such objects are illuminated by sending a strong beam of light through them, so directed that none of the direct light enters the objective, they will appear self-luminous against a background of little or no light. This method of illuminating objects (where the objects appear self-luminous against a dark field) is called dark field illumination.

Various means have been provided whereby objects under the microscope may be illuminated but with the space surrounding the objects remaining dark. The devices in general which provide this kind of illumination are

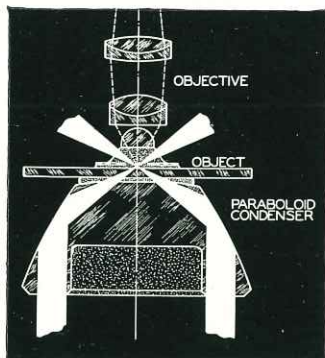
called dark field illuminators. All of them depend upon the illumination of the object by means of an annular hollow cone of light where the apex of the cone is coincident with the object. The two diagrams of Fig. 8 show a vertical section of two of these devices and the path of light through them. None of the direct rays (broad white lines) which leave the dark field illuminator will be found to enter the microscope objective. It is only when these light rays meet an object that they are reflected or refracted (dotted lines) so that they enter the microscope. The object, therefore, will appear self-luminous against a dark background.

### Light Source

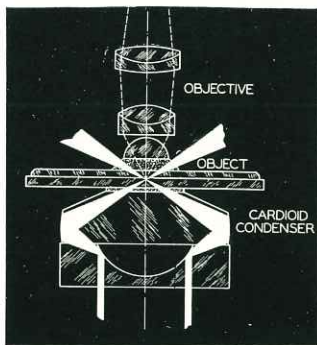
It will be impossible to use skylight or diffused light from frosted bulbs when working with a dark field illuminator. The light source should be of high intensity, such as an arc, coiled or ribbon filament lamp, fitted with a condensing lens. The lamp should be adjusted in the following manner to produce a parallel beam of light. Direct the light beam at a wall at least six feet away, and focus it until an image of the source is formed on the wall. Then

*Fig. 8—Two Forms of Dark Field Illuminators*

*Paraboloid Condenser*



*Cardioid Condenser*





adjust the lamp so that the light beam is centered on the microscope mirror.

### **Dark Field With Paraboloid Condenser**

The Paraboloid Condenser is primarily designed to be used with high power oil immersion objectives and an intense illuminant.

A cross section of this Paraboloid Dark Field Condenser is shown on page 20. Parallel light passes around the opaque central stop, and is reflected at the parabolic surface out through the upper plano surface into the slide on which the object is mounted. The correct place for the object is the point where the light comes to focus. Light passes through this point under angles equal to numerical aperture from 1.24 to 1.33. The objective used with this condenser must have a numerical aperture less than 1.24. Best results will be secured if the objective aperture is not more than 1.00 N.A.

In using this condenser it is necessary that there be immersion oil between the condenser and the slide, since the angle of incidence of light on the surface of the slide is beyond the critical angle. Furthermore, it is necessary that the specimen to be illuminated be mounted in a liquid or cement and protected with a cover glass. Above the object it does not matter what kind of objective is used, that is, either dry or immersion, so long as the numerical aperture of the objective is not as great as the numerical aperture of the condenser. A standard achromatic objective 1.8mm 1.25 N.A., with iris diaphragm for reducing the aperture, as may be required for dark field observations, is available.

For those who already have a standard 1.8mm 1.25 N.A. objective, a funnel stop (No. 31-50-15) is included with each condenser for reducing the aperture.

For best results, the glass slide upon which the specimen is mounted should be from 1.45 to 1.6mm thick.

### **Applications of the Paraboloid Condenser**

The illumination furnished by this condenser is most widely used in clinical laboratories for the examination of exudates from lesions in the search for specific organisms of the class *Treponema pallida*. It has been successfully used for the study of sera and exudates from thoracic and lung lesions. This provides a means of early diagnosis. It is also quite generally used for the examination of saliva, milk, blood, chyle, lymph, and pleural, pericardial and peritoneal fluids.

In industry the Paraboloid Condenser has many uses. In the dairy industry, motile organisms in milk can be seen with dark fields. It is useful in viewing transparent petrological preparations, as fine suspensions and inclusions in solid materials become quite visible. In studying dry powders, it reveals the microscopic structure of the particles. In the food industry this condenser is used for the study of mother liquors and fermentation of wines, vinegar, and molasses.

In bacteriological work, this condenser is used to recognize flagellated forms in unstained and living condition. It also has application in blood work on both stained and fresh material.

For teaching and demonstration purposes in biology and zoology, the Paraboloid Condenser reveals marked contrasts in protozoan groups. Cilia and flagella which have practically the same refractive index as the medium in which they are found, and might be overlooked in examination by transmitted light, are made visible.

Detailed instructions concerning the use of the Paraboloid Condenser are

included with each condenser of this type.

### **The Cardioid Condenser**

The Cardioid Condenser represents the most refined form of Dark Field Illuminator, and is usually employed for that form of dark field illumination designated as Ultramicroscopy.

Many things exist in nature too small to be seen with the microscope. Such things are said to be ultramicroscopic.

In the ordinary bright field microscope, Abbe has shown that resolution cannot be carried beyond a quarter-micron. Particles smaller than this, such as those existing in a colloidal solution, can be made visible by refined methods of dark field illumination.

The underlying principle of the visibility of ultramicroscopic particles is that, when illuminated by a strong beam of light, they deflect some of this light in all directions and thereby become luminous.

If enough of this deflected light is picked up by the eye or an optical instrument, the particles will appear as small discs of light, provided they are separated by distances resolvable by a microscope.

The Cardioid Condenser is a reflecting condenser, being free from both spherical and chromatic aberration. A cross section of this condenser is shown on page 20.

This construction of the Cardioid Condenser, in which parallel rays are subjected to successive reflections from spherical surfaces, produces a cone of light whose rays are brought to a mathematically correct focus. This extreme concentration of light, characteristic of the Cardioid Condenser is the reason for its ability to reveal the presence of extremely fine ultramicroscopic particles.

Any conventional microscope objective can be used, if its numerical

aperture is not more than 1.00 N.A. If the conventional oil immersion objective is used, it should be one with a funnel stop or an iris diaphragm.

In industry the Cardioid Condenser is very commonly used for the examination of flocculents of all sorts and liquid materials, especially in the paint and pigment industries. In the manufacture of edible and lubricating oils, colloidal suspension may be examined and the microscopic structure of paraffin crystals observed.

The Cardioid Ultramicroscope is used extensively by colloid chemists. A small drop of liquid is ample for examination. In less than five minutes time, this may be placed on the microscope and the state of subdivision determined. Conglomeration can be easily watched. Coagulation may be determined by counting particles at different intervals after adding a coagulant. The speed of Brownian movement may be used as a crude measure of the size of the particles. All well equipped chemical laboratories are most certain to find many opportunities for use of the Cardioid Condenser and its accessories.

As with the Paraboloid Condenser, detailed instructions for use are included with each Cardioid Condenser.

### **Interchange of Condenser**

In order to use either the Paraboloid or Cardioid condensers on your Labroscope, it will first be necessary to remove the bright field substage condenser, replacing it with the dark field illuminator.

To remove the Abbe condenser, loosen the small thumbscrew (Figs. 6, 9—10) and pull the condenser downward gently, removing it from the substage ring mount.

To remove the variable focus condenser, first remove the focusable lower condenser element as described above for the Abbe condenser. The fixed



upper condenser element is removed by unscrewing it from the adapter mount which is fastened to the under side of the stage. Do not remove the adapter mount itself, as the upper con-

denser element will, in all probability, be decentered upon replacement.

For further adjustment of the dark field illuminator, refer to the Reference Manual which accompanies it.

## THE BINOCULAR BODY

The addition of a binocular body to a microscope adds greatly to the comfort of observation, particularly if observations are to be made over an extended period of time.

In manipulation, there are two adjustments which must be made on the microscope which is equipped with a binocular body which are not necessary on the monocular body. First, the separation of the eyepieces must be adjusted so that they match the separation of the observer's eyes (the interpupillary distance), and secondly, the eyepieces must be adjusted so that the image presented to each eye is in exact focus. Once these two adjustments

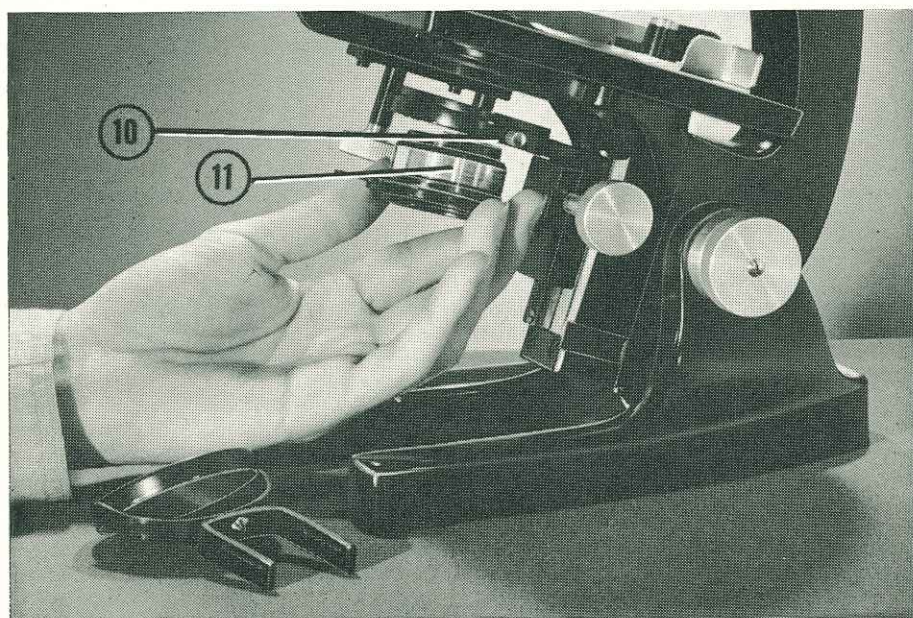
have been made for any particular observer, they need not be made again.

### Interpupillary Adjustment

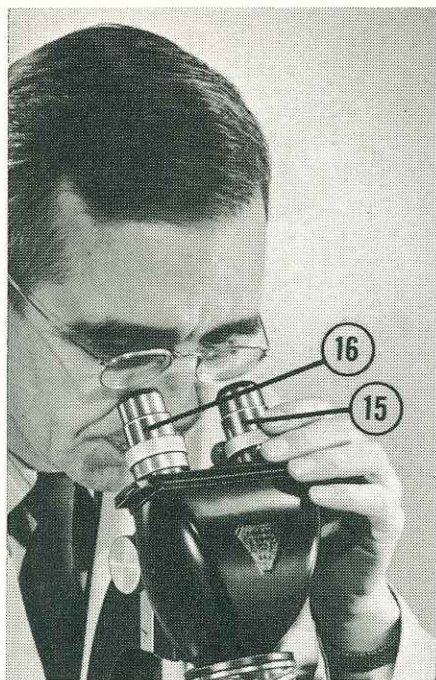
The separation of the two eyepiece tubes can be varied by rotating the knurled ring located on the left hand eyepiece tube (Fig. 10—15). A millimeter scale is provided by means of which the observer can note the correct setting after the adjustment has once been made, and thereafter he can make the adjustment, if necessary, by merely setting to the known scale reading.

The adjustment for interpupillary distance is important. If not carefully

*Fig. 9—Removing the Condenser*







*Fig. 10—Adjustment of the Binocular Body*

carried out, you may be getting binocular vision in only a small part of the field and nothing more than monocular vision in the rest. When you think you have an approximate adjustment, test by alternately obscuring the eyepieces, either by alternately closing the eyes or by using two cards. After one eye has been closed, an impression remains for a part of a second, and if the other eye is uncovered immediately it is possible to become conscious of the two fields simultaneously. If each eye is seeing a complete field, the adjustment is practically complete. Vision with both eyes should now result in a completely fused single image.

#### **Adjustment for Focus**

It has been well established that most people do not have eyes which are perfectly matched for focus. In order

to compensate for this discrepancy between the focus of the two eyes, one eyepiece of the binocular body is provided with a focusing collar to permit independent focusing of that one eyepiece. To effect this adjustment, focus the microscope, using the coarse and fine adjustments in the usual manner, so that the sharpest image is obtained for the left eye. If the image is not sharp for the right eye it can be brought into focus by rotating the focusing collar on the right eyepiece tube (Fig. 10—16), thereby raising or lowering the eyepiece as necessary.

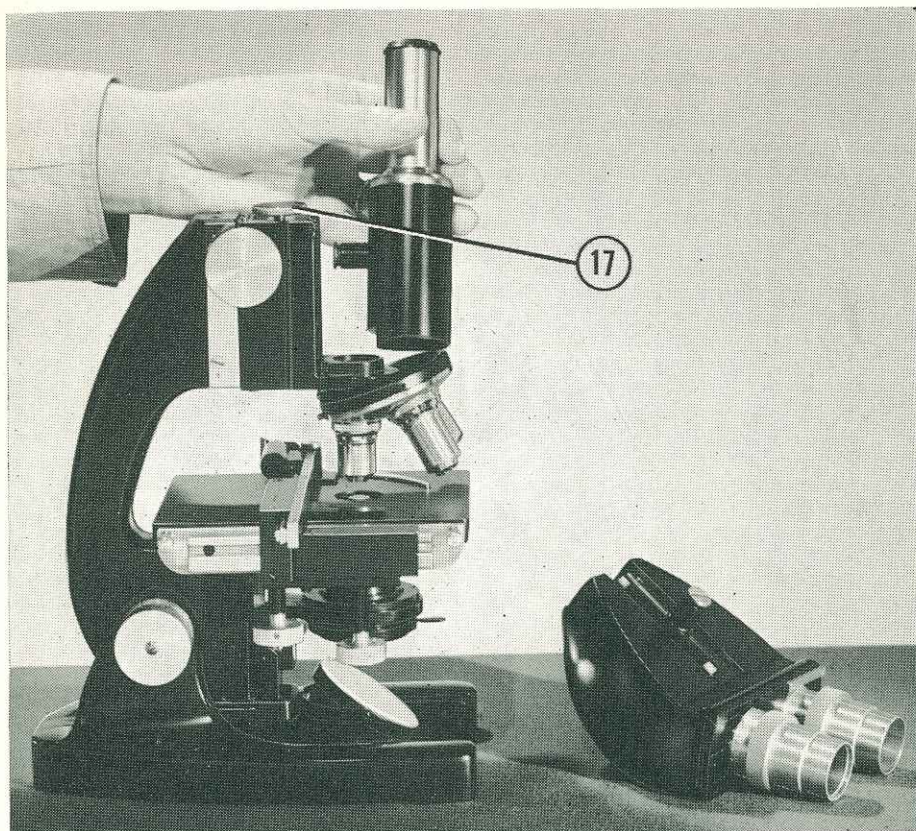
This adjustment of focus should be made after the adjustment for interpupillary distance is made, as there is a slight change of focus as the eyepiece separation is varied.

The prisms within the binocular body have been accurately centered at the factory and should never be tampered with. A slight shift of one of the prisms will cause a misalignment of the optical axis of the two eyepiece tubes, resulting in eye strain during observation.

#### **Interchange of Monocular and Binocular Bodies**

The binocular body is useful as an aid to visual observation but is not adaptable to use on the microscope for photomicrography or projection purposes. All Bausch & Lomb Labrosopes, Series T and C, have provision for accepting either a binocular or monocular body. Figure 11 illustrates the method of interchange of these bodies. It is only necessary to loosen the knurled body lock screw (Figs. 3 and 11—17) remove one body and replace it by the other, then tighten the screw. Care should be exercised that the bearing surfaces on the microscope and body tube are free of dirt, burrs, etc. which may cause the body tube to be tilted.





*Fig. 11—Interchange of Monocular and Binocular Bodies*

## THE COVER GLASS

The cover glass, which is normally placed over the specimen, might appear to be a rather insignificant item and little consideration given to it in the preparation of the specimen slide. This, however, is far from true, as the cover glass, especially when dealing with high power dry objectives, becomes an integral part of the optical system. The microscope objectives which are to be used on the Labroscope have been designed to be used with cover glasses which are made of crown glass of refractive index  $n_D = 1.523$  and are 0.18mm thick. A variation of only a very few hundredths of a millimeter in

thickness is sufficient to cause a marked deterioration of the image when using, say, the  $43\times$  (4mm) 0.65 N.A. objective.

Cover glasses are available from any laboratory supply house and are usually sold according to thickness. The usual commercial classifications are Nos. 1, 2, and 3, the thickness range of each group being:

No. 1, 0.13 to 0.17mm thick

No. 2, 0.17 to 0.25mm thick

No. 3, 0.25 to 0.50mm thick

Cover glasses of thickness No. 1 and No. 2 are the ones with which one is normally concerned.



No. 1 cover glasses are principally used on specimens which are to be studied under the oil immersion objective. Since oil, of approximately the same refractive index as that of the cover glass and the front lens of the objective, is to be used, the thickness of the cover glass is not significant from the optical viewpoint. However, oil immersion objectives have a very short working distance (distance from front of the objective to the specimen) and, with too thick a cover glass, it will be impossible to focus on the specimen. Therefore, the thinner cover glasses are advantageously used in these cases.

No. 2 cover glasses should be used for specimens examined under the low and high power dry objectives, the thicker glasses in this group being used for the low powers. For optimum per-

formance with the higher power dry objectives (0.65—0.85 N.A.), cover glasses exactly 0.18mm thick, as measured with a micrometer caliper, should be used.

Compensation for cover glasses which are too thick or too thin may be made if the microscope is equipped with a draw tube, but generally speaking it is preferable to use controlled cover slides rather than resort to an adjustable draw tube, as the latter upsets parfocality. The 4mm 0.95 N.A. apochromatic objective is fitted with a graduated correction collar which may be set for the particular thickness of the cover glass in use. This is provided because of the extreme sensitivity to cover glass thickness of this particular objective.

## THE DRAW TUBE

Some models of microscopes are furnished with draw tubes in place of the fixed eyepiece tube adapter. The draw tube is graduated on the side in millimeters, and has at its lower end an adapter with a Society screw thread. The draw tube serves three purposes.

The first and most important purpose is to compensate small differences in cover glass thickness when high power dry objectives of high N.A. are used. The draw tube should normally be set to read 160mm at the fitting on the top of the body tube. The object slide should be prepared with an 0.18mm cover glass over the specimen. In case the cover glass is not exactly 0.18mm thick, increasing the tube length 10mm will compensate a decrease of 0.01mm in cover glass thickness. Likewise, decreasing the tube length 10mm balances an increase of 0.01mm in cover glass thickness. This change in tube length to balance variation in cover glass thickness only ap-

plies to high power dry achromatic and fluorite objectives.

The second purpose is to permit small changes in initial magnifications so that, in calibrating micrometer eyepieces (page 28) for purposes of measuring, an even factor may be secured. An increase of 10mm in the tube length increases the magnification by approximately 6%.

The third purpose is to hold a low power objective and thereby secure lower magnifications than if the same objective were held in the nosepiece. To use the draw tube in this manner, one of the objectives on the multiple nosepiece must be removed and this aperture brought into the microscope axis. Unscrew the fitting at the top of the body tube. This fitting carries the draw tube with it. Screw into the nosepiece of the draw tube the low power objective. Replace the draw tube and focus by means of sliding the draw tube in the microscope and by the



coarse adjustment head. The  $2\times$  (48mm),  $2.6\times$  (40mm) and the  $4\times$

(32mm) objectives are the only ones which may be used in this manner.

## THE MECHANICAL STAGE

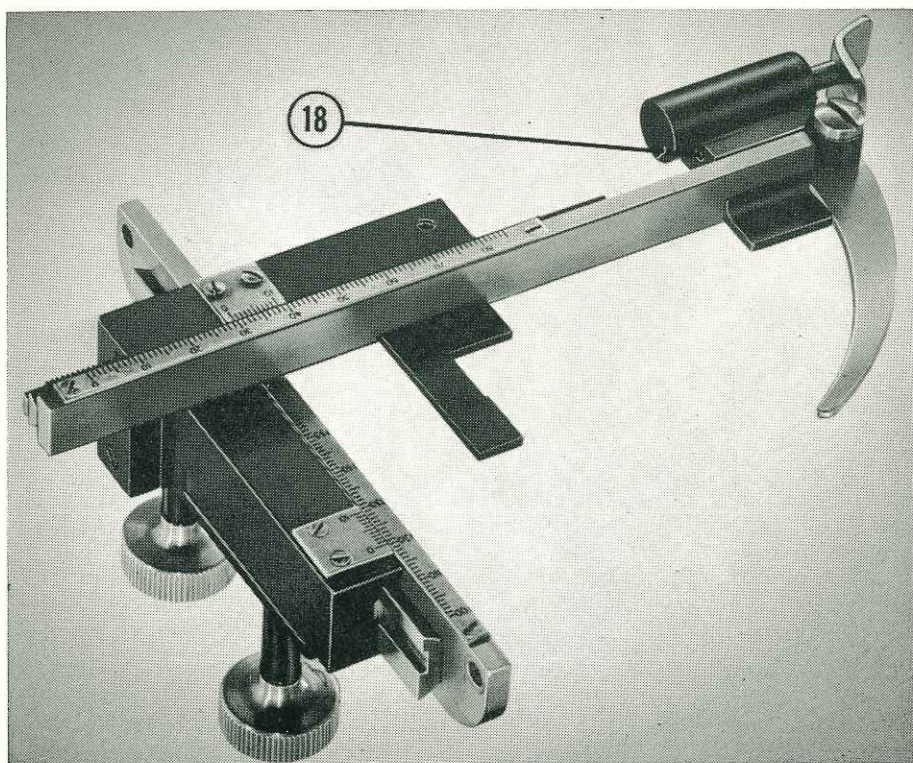
The mechanical stage is of great value in the operation of searching a specimen for points of particular interest, and permits one easily and precisely to bring any desired area of the specimen to the center of the field of view for critical examination. The graduated mechanical stage (Fig. 12), equipped with verniers reading to 0.1mm, makes possible the recording of the location of any particular area of the specimen for examination at a later time. Also, length or separation measurements (to 0.1mm) may be made with the graduated mechanical stage.

The low position of the stage controls, in addition to the low position fine adjustment knob, makes for a compact operating area which requires a minimum amount of hand movement in going from the fine adjustment to the stage controls.

### Attaching Stage to Microscope

A mechanical stage may be added to your Labroscope at any time without the necessity of returning the microscope to the factory. The procedure is very simple. Remove the spring clips from the microscope stage. Remove

*Fig. 12—Graduated Mechanical Stage*



the two small screws located at the front and rear of the right side of the stage. Place the mechanical stage as shown in Fig. 1, lining up the two drilled holes in the side of the stage with the screw holes exposed by the removal of the two screws from the microscope stage. Secure it in place with the two knurled head screws which are provided with the mechanical stage.

### **Adjusting Tension of Control Buttons**

The tension of the operating buttons may be adjusted to suit the preference of the operator. The tension should be adjusted so that only a moderate amount of pressure is required to operate the stage, but not so loosely that the stage will move should the hand accidentally brush the buttons. This adjustment is to be made on each button individually, and is effected by first loosening the small screw which is located on the periphery of the knurled portion of the button. Then tighten or loosen, as desired, the screw which extends through the bottom of the but-

ton and secures the button to the shaft. When the desired tension is obtained, tighten the small screw which was first loosened.

### **Vacu-trol Adjustment**

The closing of the slide finger, upon releasing the slide finger control lever, is effected by a vacuum-controlled spring. The retarding force of the vacuum may be regulated by adjustment of the small screw, (Fig. 12—18) with a jeweler's small screwdriver. As the screw is unscrewed, the vacuum becomes less effective and the slide finger will close faster and with greater force. The proper adjustment is such that there is an ideal compromise between speed of closing and the contacting force between the finger and the corner of the slide. If the finger closes too rapidly, there is danger of chipping or breaking the slide. The holding power of the slide finger is not affected by this adjustment, as once contact is made between finger and slide, the slide is held under a constant and uniform pressure.

## **MEASURING WITH THE MICROSCOPE**

Eyepieces fitted with micrometer discs are known as micrometer eyepieces, and are used for measuring the linear dimensions of microscopic objects. Micrometer discs are either glass plates of a diameter which permits introducing them into standard eyepieces, or they are mounted permanently in an eyepiece. The first type should be placed on the eyepiece diaphragm with the scale downwards. The second type is available in two forms, in one of which the plate is fixed in position and in the other movable laterally by means of a screw.

Before measurements can be made with any eyepiece micrometer it must

be calibrated for the particular objective, eyepiece, and tube length employed.

This consists of determining the magnification factor, or the value of a division in the eyepiece scale of a known dimension, shown magnified in the field of view. For this purpose, a stage micrometer is required. This is usually a glass slide carrying a scale of known intervals.

The first step is to focus the stage micrometer scale. Then set the stage micrometer so that one line on it coincides with a line to left center of the eyepiece scale. Count across the eyepiece scale to right from this point to



another point where a line of the eyepiece scale coincides with a line on the stage micrometer scale. If no lines coincide within the range of the eyepiece scale, estimate the fraction of a division marked by a line on one scale by the other.

### Magnification Factor Method

When both stage micrometer and eyepiece micrometer are graduated in the same system, it is very easy to determine the number of times an object is magnified by the objective and field lens of the eyepiece when focused in the plane of the eyepiece micrometer disc. Therefore, the size of any object, as shown on the eyepiece scale, will be that dimension divided by the magnification factor. To determine the magnification factor, divide the dimension subtended in the eyepiece scale by the actual dimension on the stage micrometer scale included. Thus, if 0.1mm on the stage covers 1.86mm on the eyepiece scale, the magnification factor is 18.6 ( $1.86 \div 0.1 = 18.6$ ). If an object subtends 0.25mm in the eyepiece, its actual size is  $0.25\text{mm} \div 18.6 = 0.0134\text{mm}$ .

### Eyepiece Scale Value Method

If the value of the eyepiece micrometer scale is not known, this method is more convenient. In this case one simply determines the number of divisions in the eyepiece scale subtended by a known value on the stage micrometer when in focus.

To determine the value of one eyepiece scale interval, simply divide the value of the stage micrometer interval by the number of eyepiece scale intervals which it subtends in the image.

For instance, 0.1mm on the stage micrometer scale covers 18.6 divisions in the eyepiece scale. Therefore, one division of the eyepiece scale equals  $0.1\text{mm} \div 18.6\text{mm}$  or 0.00537. The

size of an object subtending 2.5 divisions in the eyepiece will be  $2.5 \times 0.00537 = 0.0134\text{mm}$ .

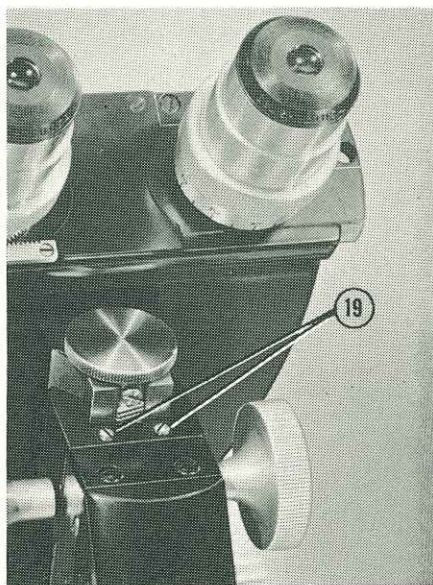
In calibrating the instrument and in making measurements, it is important that the object and the eyepiece micrometer scale appear to lie exactly in the same plane. This can be brought about by careful attention to focusing.

### Care of the Labroscope and Its Accessories

Your Bausch & Lomb Labroscope has been constructed with skill and care to provide you with an instrument which will give years of satisfactory service. It must be remembered, however, that even with its rugged construction, it is a precision instrument and should be given fitting care. When treated with the proper respect and given a reasonable amount of care, your Labroscope will show little if any signs of wear after even the most protracted use.

Care should not be confined to the

*Fig. 13—Coarse Adjustment Pinion Adjusting Screws*



optical elements alone. The Labroscope is a combination of optical and mechanical excellence, one complementing the other. Of what value is the most perfect objective if the fine focusing mechanism cannot bring it precisely into perfect focus?

An excellent rule to observe is not to permit any unauthorized person to manipulate your microscope. One person may be an expert in the manipulation of one type of instrument but be completely unfamiliar with another. If it should be necessary for someone else to use your microscope, be sure to instruct him thoroughly in its proper use.

The primary rule to follow with respect to proper care of the microscope is to keep it as free from dust and dirt as is possible. Dusty lenses will result in foggy images while dust in the focusing mechanisms will give rise to excessive wear of these parts. When not in use, cover the microscope with the plastic dust protecting cover which accompanies it. If the microscope is not to be used for some time, keep it in its case.

When handling the stand, it is best to carry it by the arm and base. It would be wise to use two hands rather

than risk dropping the instrument.

Avoid sudden jars, such as placing the microscope on the table or into the case with undue force.

Remove any immersion oil which may adhere to any part of the stand with a cloth moistened with xylol and wipe dry with a soft lintless cloth or chamois.

Special care should be taken to keep the coarse adjustment free from dust and grime. The slides and rack and pinion are necessarily exposed and the lubricant is apt to catch dust and also to gum. The body tube, along with the coarse adjustment rack and pinion, should be withdrawn occasionally and the bearing surfaces wiped with a cloth moistened with xylol. Lubricate by applying a thin film of white vaseline to the bearing surfaces, removing any superfluous amount with a dry cloth. The teeth of neither the rack nor pinion should ever be lubricated. An occasional cleaning of these parts with an old toothbrush is advisable.

It is possible to adjust the tension of the coarse adjustment pinion by proper setting of the two small screws (Fig. 13—19) on the top of the rack slide.

The instructions given for the cleaning and lubrication of the coarse adjustment apply equally as well to the substage rack and pinion. To adjust the pressure on the substage pinion, tighten or loosen the two screws (Fig. 14—20) until the desired tension is obtained.

The rack and pinion and the bearing surfaces of the mechanical stage should receive the same attention given to the coarse adjustment and the substage. In this case, however, it is preferable to use a light machine oil as the lubricant.

The fine adjustment requires no attention from the user other than proper manipulation during use of the microscope. Should the fine adjust-

*Fig. 14—Substage Rack and Pinion  
Pressure Screws*





ment cease to function satisfactorily, the instrument should be returned to the factory. It is safe to say that, as a general rule, only a rather violent accident or severe mistreatment will result in failure of the fine adjustment. If the fine adjustment button ceases to rotate, it indicates that the adjustment screw has reached the limit of its motion at one end or the other. It should by no means be forced; it should at all times be kept toward the center of its motion.

Should the tension of the inclination joint become too loose, it is easily tightened by tightening the two screws, one on each pillar of the microscope base. Figure 15 illustrates this adjustment being made.

#### **Care of Objectives and Eyepieces**

Every outfit should be provided with a camel's hair brush and a well washed piece of linen. On account of its fine texture, chamois skin is desirable, but only after it has been repeatedly washed. No dust should be permitted to settle upon the lenses nor should the finger come into contact with any of the surfaces.

The lens systems should never be separated, even if they can be unscrewed, as they are liable to become decentered and dust may enter.

Avoid all violent contact of the front lens with the cover glass. The oil immersion objectives particularly require the best care.

Occasionally examine the rear surface of the objective with a magnifier, and if dust be present remove it with a camel's hair brush, or blow it off with air from a syringe.

Clean an immersion objective im-

mediately after it has been used by removing the fluid with lens paper.

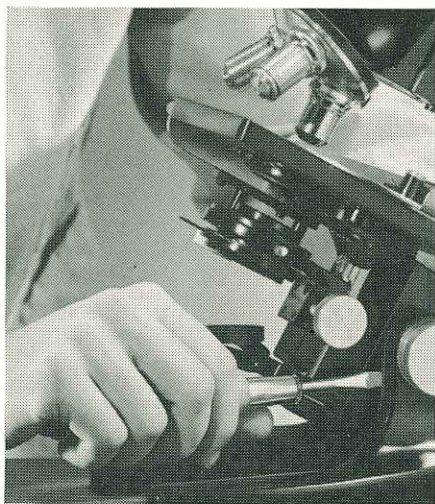
While cleaning, give the objective a revolving motion.

Visible defects in the field are frequently traceable to impurities on the eyepiece, not in the objective, and are easily recognized by revolving the eyepiece. Indistinctness in the image or loss of light may be due to soiled surfaces in either eyepiece or objective.

Dust, if on either the eyelens or field lens, is apparent as dark, indistinct spots.

To clean the surfaces, first blow upon them or, preferably, blow the dust away with a gentle blast of dry air from a syringe. Then remove all dust possible with a camel's hair brush. If dirt or grease is still evident, remove it by gently wiping with a soft, lintless cloth moistened with xylol.

*Fig. 15—Adjusting the Tension of the Inclination Joint*



TOTAL MAGNIFICATION TABLE

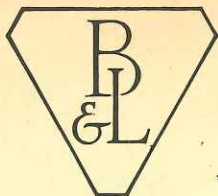
| OBJECTIVE<br>MAGN. NO. | TYPE         | EYEPiece MAGNIFICATION |      |      |      |       | EQUIVALENT<br>FOCAL<br>LENGTH<br>MM | NUMERICAL<br>APERTURE | WORKING<br>DISTANCE<br>IN MM |
|------------------------|--------------|------------------------|------|------|------|-------|-------------------------------------|-----------------------|------------------------------|
|                        |              | 5×                     | 6.4× | 7.5× | 10×  | 12.5× | 15×                                 |                       |                              |
| 2                      | Achromatic   | 10.0                   | 12.8 | 15.0 | 20.0 | 25.0  | 30.0                                | 0.08                  | 53.0                         |
| 2.6                    | Achromatic   | 13.0                   | 16.6 | 19.5 | 26.0 | 32.5  | 39.0                                | 0.08                  | 43.5                         |
| 3.5                    | Achromatic   | 17.5                   | 22.4 | 26.2 | 35.0 | 43.8  | 52.5                                | 0.09                  | 17.8                         |
| 4                      | Achromatic   | 20.0                   | 25.6 | 30.0 | 40.0 | 50.0  | 60.0                                | 0.10                  | 38.0                         |
| 6                      | Achromatic   | 30.0                   | 38.4 | 45.0 | 60.0 | 75.0  | 90.0                                | 0.17                  | 15.5                         |
| 10                     | Achromatic   | 50.0                   | 64.0 | 75.0 | 100  | 125   | 150                                 | 0.25                  | 8.3                          |
| 21                     | Achromatic   | 105                    | 134  | 158  | 210  | 262   | 315                                 | 0.50                  | 1.7                          |
| 43                     | Achromatic   | 215                    | 275  | 322  | 430  | 538   | 645                                 | 0.65                  | 0.72                         |
| 45                     | Achromatic   | 225                    | 288  | 338  | 450  | 562   | 675                                 | 0.85                  | 0.34                         |
| 60                     | Achromatic   | 300                    | 384  | 450  | 600  | 750   | 900                                 | 0.85                  | 0.17                         |
| 97                     | Achromatic   | 485                    | 621  | 728  | 970  | 1212  | 1455                                | 1.25 oil              | 0.14                         |
| 40                     | Fluorite     | 200                    | 256  | 300  | 400  | 500   | 600                                 | 1.00 oil              | 0.27                         |
| 43                     | Fluorite     | 215                    | 275  | 322  | 430  | 538   | 645                                 | 0.85                  | 0.34                         |
| 98                     | Fluorite     | 490                    | 627  | 735  | 980  | 1225  | 1470                                | 1.30 oil              | 0.13                         |
| 10                     | Apochromatic | 50.0                   | 64.0 | 75.0 | 100  | 125   | 150                                 | 0.30                  | 4.86                         |
| 20                     | Apochromatic | 100                    | 128  | 150  | 200  | 250   | 300                                 | 0.65                  | 0.67                         |
| 47.5                   | Apochromatic | 238                    | 304  | 356  | 475  | 594   | 712                                 | 0.95                  | 0.20                         |
| 61                     | Apochromatic | 305                    | 390  | 458  | 610  | 762   | 915                                 | 1.40 oil              | 0.15                         |
| 90                     | Apochromatic | 450                    | 576  | 675  | 900  | 1125  | 1350                                | 1.30 oil              | 0.12                         |
| 90                     | Apochromatic | 450                    | 576  | 675  | 900  | 1125  | 1350                                | 1.40 oil              | 0.07                         |
| 00                     | Apochromatic | 000                    | 000  | 000  | 000  | 000   | 000                                 | 0.00                  | 0.00                         |



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If shipment shows evidence of rough handling, have the agent note on the receipt "Received in bad order"; or if "concealed damage" is revealed after unpacking, call the representative of the transportation company within 48 hours and have him make out a "Bad order" report. Unless this procedure is followed, you lose all right to recovery from the carrier. —Bausch & Lomb Optical Co.

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DI-776, 6. AUG. '51

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